ON THE REALIZATION OF DO-OTA-C OSCILLATORS

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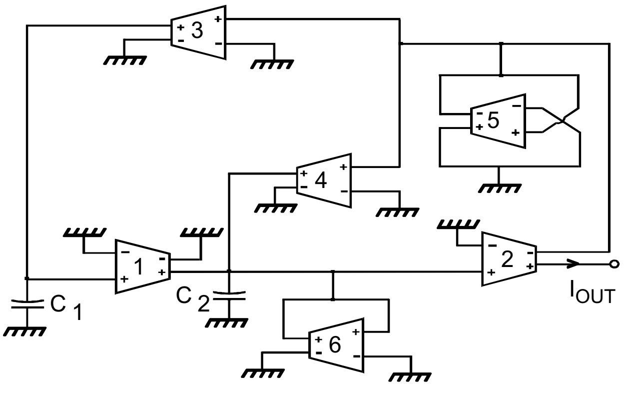
Abstract

The basic aim of this paper is to give design considerations of current-mode high frequency DO - OTA - C oscillator topologies achieving noninteractive control of b and Ω_0 *with a minimum number of components. Starting from DO-OTA-C (grounded capacitor) filter topologies, reported in the literature and employing a minimum number of components, novel DO - OTA - C oscillator topologies are generated by converting of filters into oscillators. Furthermore, the influence of the OTA nonidealities on oscillator performance is investigated by including the finite input and output impedances and transconductance frequency dependencies of DO-OTAs into derived equations. The performance of the proposed topologies are demonstrated with SPICE simulation program*

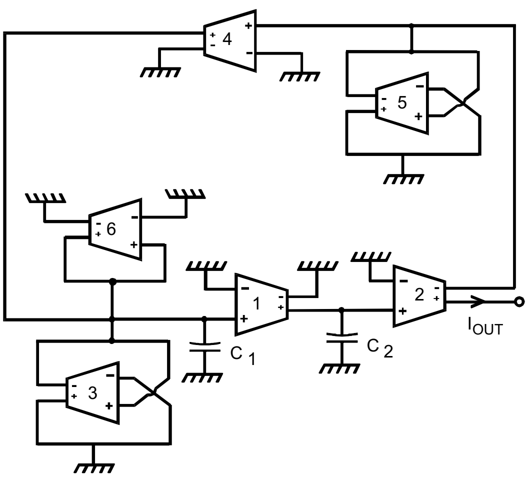
Reference

H. Kuntman, A. Özpınar, On the realization of DO-OTA-C oscillators, Microelectronics Journal, Vol.29, No. 12, pp.991-997, 1998.



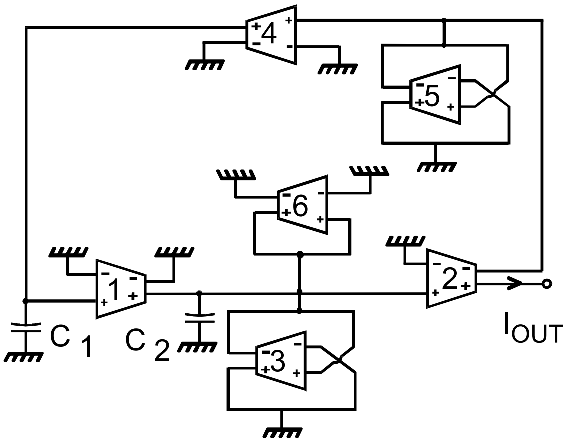
3
5
4
1
2
6
C 1
C 2
IOUT

(a)



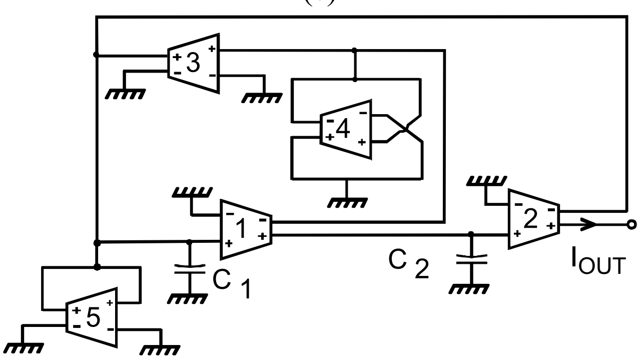
4
5
6
1
2
3
C 1
C 2
IOUT

(b)



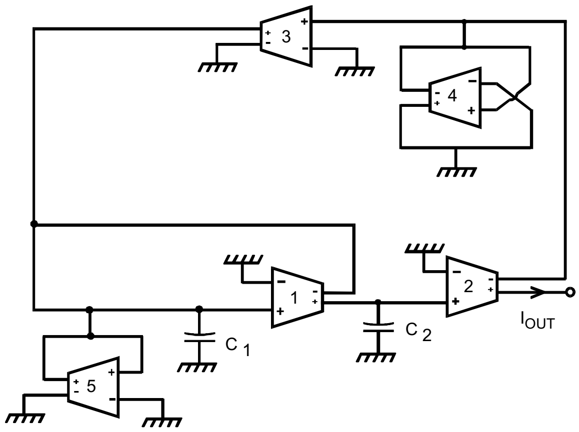
4
5
6
1
2
3
C 1
C 2
IOUT

(c)



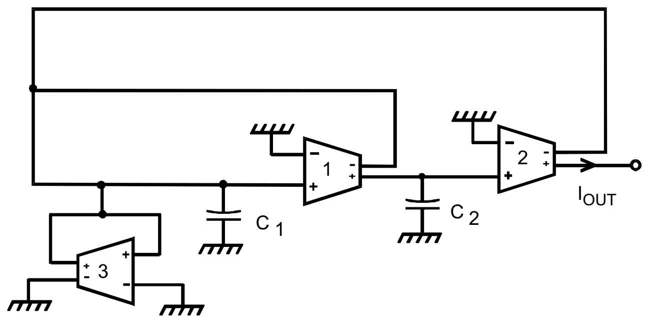
3
4
1
2
5
C 1
C 2
IOUT

(d)



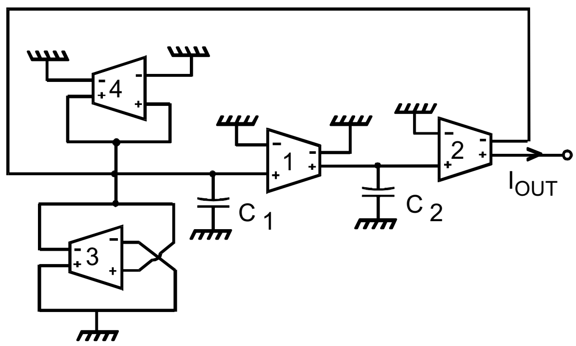
3
4
1
2
5
C 1
C 2
IOUT

(e)



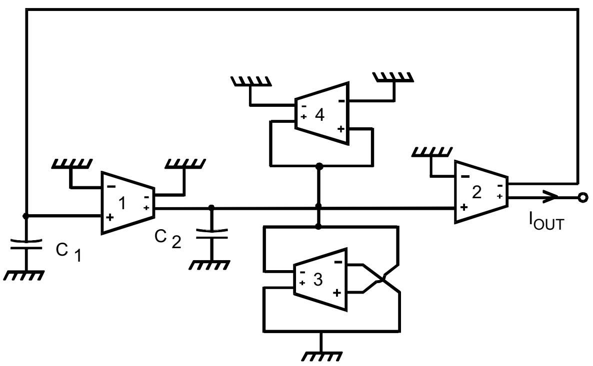
1
2
3
C 1
C 2
IOUT

(f)



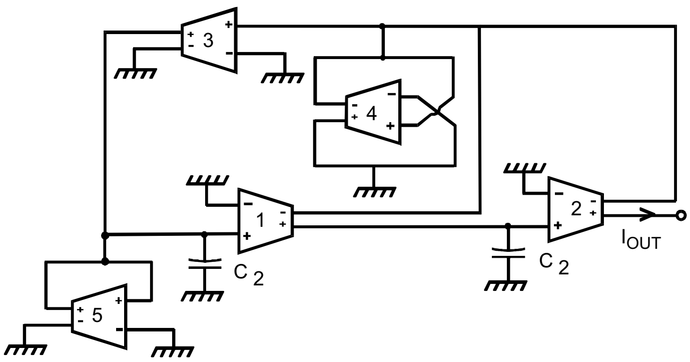
4
1
2
3
C 1
C 2
IOUT

(g)



4
1
2
3
C 1
C 2
IOUT

(h)



(i)

Figure 1. Proposed DO-OTA-C oscillator topologies.

Table-1. Expressions for oscillation conditions and oscillator frequencies of topologies illustrated in Fig.1, derived assuming ideal OTAs..

Topology	**b**	$\boldsymbol{\Omega_O^2}$
Figure 1a	$\dfrac{\dfrac{g_{m2}\cdot g_{m4}}{g_{m5}} - g_{m6}}{C_2}$	$\dfrac{g_{m1}\cdot g_{m2}\cdot g_{m3}}{C_1 C_2 g_{m5}}$
Figure 1b	$\dfrac{g_{m3} - g_{m6}}{C_1}$	$\dfrac{g_{m1}\cdot g_{m2}\cdot g_{m4}}{C_1 C_2 g_{m5}}$
Figure 1c	$\dfrac{g_{m3} - g_{m6}}{C_2}$	$\dfrac{g_{m1}\cdot g_{m2}\cdot g_{m4}}{C_1 C_2 g_{m5}}$
Figure 1d	$\dfrac{\dfrac{g_{m1}\cdot g_{m3}}{g_{m4}} - g_{m5}}{C_1}$	$\dfrac{g_{m1}\cdot g_{m2}}{C_1 C_2}$
Figure 1e	$\dfrac{g_{m1} - g_{m5}}{C_1}$	$\dfrac{g_{m1}\cdot g_{m2}\cdot g_{m3}}{C_1 C_2 g_{m4}}$
Figure 1f	$\dfrac{g_{m1} - g_{m3}}{C_1}$	$\dfrac{g_{m1}\cdot g_{m2}}{C_1 C_2}$
Figure 1g	$\dfrac{g_{m3} - g_{m4}}{C_1}$	$\dfrac{g_{m1}\cdot g_{m2}}{C_1 C_2}$
Figure 1h	$\dfrac{g_{m3} - g_{m4}}{C_2}$	$\dfrac{g_{m1}\cdot g_{m2}}{C_1 C_2}$
Figure 1i	$\dfrac{\dfrac{g_{m1}\cdot g_{m3}}{g_{m4}} - g_{m5}}{C_1}$	$\dfrac{g_{m1}\cdot g_{m2}\cdot g_{m3}}{C_1 C_2 g_{m4}}$

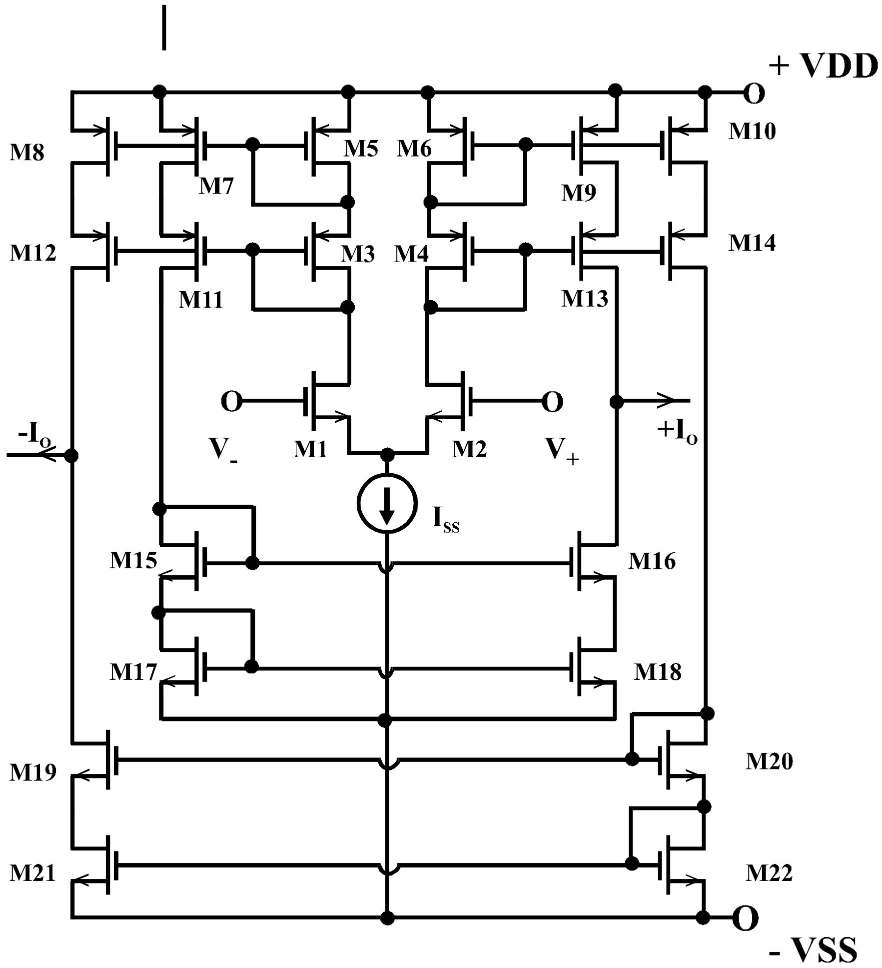


Figure 3. CMOS cascode DO-OTA structure used for SPICE simulations.

Table-3 . Dimensions of MOS transistors in CMOS DO-OTA structure shown in Fig.

	$W(\mu m)$	$L(\mu m)$
M1	30	3
M2	30	3
M3	12	3
M4	12	3
M5	12	3
M6	12	3
M7	12	3
M8	12	3
M9	12	3
M10	12	3
M11	12	3

	$W(\mu m)$	$L(\mu m)$
M12	12	3
M13	12	3
M14	12	3
M15	5	3
M16	5	3
M17	5	3
M18	5	3
M19	5	3
M20	5	3
M21	5	3
M22	5	3

Table 6. SPICE simulation results of output current and output voltage performed for different load resistance values.

Figure 1a	**I_{OUTpp}**	**V_{OUTpp}**	**frequency**
$R_L = 1\ \Omega$	376.255 µA	376.255 µV	1.297MHz
$R_L = 1\ k\Omega$	372.208 µA	372.208 mV	
$R_L = 10\ k\Omega$	398.098 µA	3.98098 V	
Figure 1b			
$R_L = 1\ \Omega$	616.392 µA	616.392 µV	1.357791 MHz
$R_L = 1\ k\Omega$	709.969 µA	709.968 mV	
$R_L = 10\ k\Omega$	668.157 µA	6.6815 V	
Figure 1c			
$R_L = 1\ \Omega$	656.413 µA	656.413 µV	1.4315818 MHz
$R_L = 1\ k\Omega$	649.716 µA	649.716mV	
$R_L = 10\ k\Omega$	602.833 µA	6.0283 V	
Figure 1d			
$R_L = 1\ \Omega$	1006.509 µA	1006.509 µV	1.369527 MHz
$R_L = 1\ k\Omega$	1007.313 µA	1007.313 mV	
$R_L = 5\ k\Omega$	975.762 µA	4.8788 V	
Figure 1e			
$R_L = 1\ \Omega$	718.012 µA	718.012 uV	1.3553606 MHz
$R_L = 1\ k\Omega$	720.880 µA	720.880 mV	
$R_L = 10\ k\Omega$	688.346 µA	6.8835 V	
Figure 1f			
$R_L = 1\ \Omega$	731.044 µA	731.451 uV	1.365707 MHz
$R_L = 1\ k\Omega$	774.261 µA	774.261 mV	
$R_L = 10\ k\Omega$	747.489 µA	7.4761 V	
Figure 1g			
$R_L = 1\ \Omega$	714.922 µA	714.922 µV	1.3608219 MHz
$R_L = 1\ k\Omega$	736.624 µA	736.624 mV	
$R_L = 10\ k\Omega$	699.877 µA	6.796 V	
Figure 1h			
$R_L = 1\ \Omega$	679.074 µA	679.074 µV	1.349757 MHz
$R_L = 1\ k\Omega$	704.037 µA	704.037 mV	
$R_L = 10\ k\Omega$	675.921 µA	6.7592 V	
Figure 1i			
$R_L = 1\ \Omega$	642.317 µA	642.317 µV	1.509787 MHz
$R_L = 1\ k\Omega$	650.343 µA	650.343 mV	
$R_L = 10\ k\Omega$	576.071 µA	5.7607 V	

Table 5. Theoretical and simulation results of oscillation frequeny obtained for proposed oscillator topologies

Topology	Theory	Simulation with actual CMOS DO-OTAs
Figure 1a	1.342 MHz	1.297 MHz
Figure 1b	1.433 MHz	1.358 MHz
Figure 1c	1.488 Mhz	1.431 MHz
Figure 1d	1.472 MHz	1.37 MHz
Figure 1e	1.433 MHz	1.355 MHz
Figure 1f	1.433 MHz	1.365 MHz
Figure 1g	1.433 MHz	1.36 MHz
Figure 1h	1.433 MHz	1.35 MHz
Figure 1i	1.537 MHz	1.509 MHz

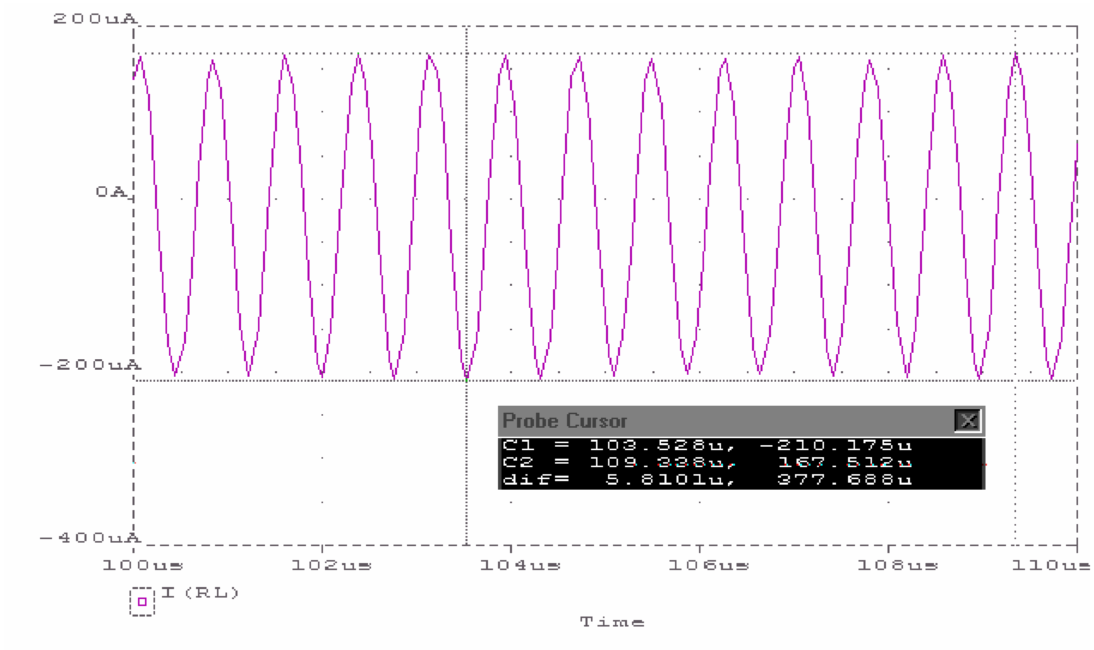


Fig.5. Simulated waveform for output current of oscillator topology illustrated in Fig.1a., $C_1 = C_2 = 50$ pF, RL = 1000 Ω